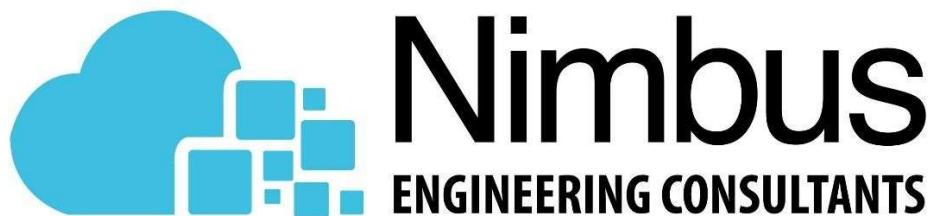


DRAINAGE STRATEGY REPORT FOR KNOWLES QUARRY BARNSELEY ROAD, CUDWORTH S72 8UU

DOCUMENT NUMBER.: C2957-R1-REV-A

PREPARED BY



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1. INTRODUCTION

1.1 Appointment

Nimbus Engineering have been appointed to provide solution on the management of Foul Water and Surface Water run-off and to ensure that there is no risk of flooding caused by the proposed new assisted living accommodation development at Knowles Quarry, Barnsley Road, Cudworth, S72 8UU.

1.2 Objectives

This report will provide information on a suitable drainage strategy as requested by the Local Authority.

1.3 Limitations

The general limitations of this report are:

- A number of data and information sources have been used to prepare this report. Whilst Nimbus Engineering believes them to be trustworthy, Nimbus Engineering is unable to guarantee the accuracy of data and information that has been provided by others;

- This report has been prepared using the best data and information that was available at the time of writing. There is the potential for further information or data to become available, leading to changes in the conclusions drawn by this report, for which Nimbus Engineering cannot be held responsible.

2. GEOLOGY OF THE AREA

According to the British Geological Survey, the superficial deposit at the site are unknown, as shown in Figure 1 below. The bedrock at the site is made up of Ackton Rock, consisting of sandstone, as shown on Figure 2, below.

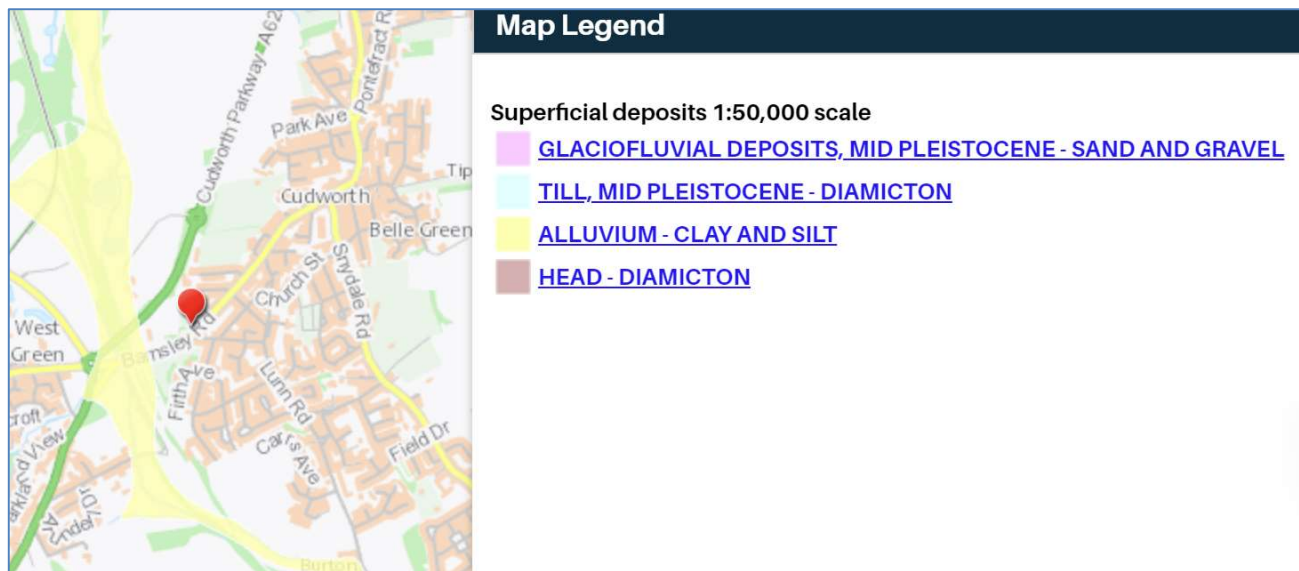


Figure 1- Superficial deposits at the site. (Source: British Geological Society Website (contains British Geological Survey) [2023])

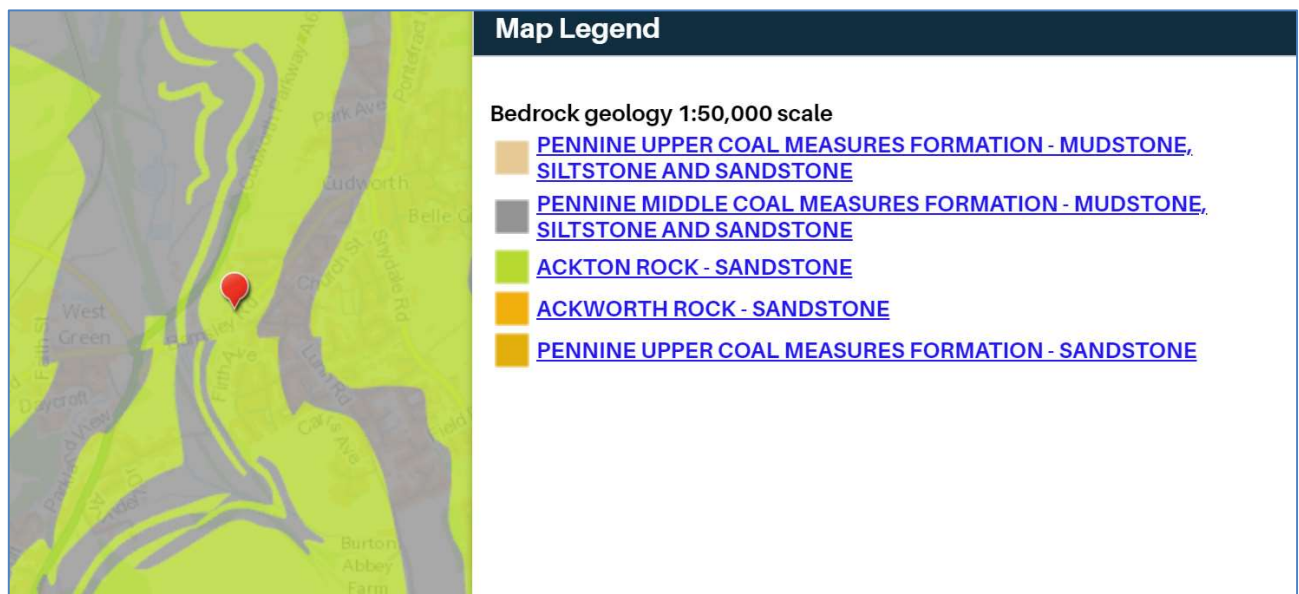


Figure 2- Bedrock at the site. (Source: British Geological Society Website (contains British Geological Survey) [2023])

Due to the underlying geology consisting of mudstone, infiltration will not be feasible at this site.

3. SUSTAINABLE URBAN DRAINAGE SYSTEMS

Surface water arising from a developed site should, as far as is practicable, be managed in a sustainable manner to mimic the surface water flows arising from the site prior to the proposed development, while reducing the flood risk to the site itself and elsewhere, taking climate change into account.

Reducing the rate of surface water discharge from urban sites is one of the most effective ways of reducing and managing flood risk.

Traditional piped surface water systems work by removing surface water from our developments as quickly as possible, however this can cause various adverse impacts:

- Increased downstream flooding, and sudden rises in flow rates and water levels in local water courses.
- Reduction in groundwater levels and dry weather flows in watercourses.
- Reduce amenity and adversely affect biodiversity due to the surface water runoff containing contaminants such as oil, organic matter and toxic materials.

SuDS are defined as a sequence of management principles and control structures designed to drain surface water in a more sustainable fashion than conventional piped drainage techniques. SuDS should utilise the natural landscape of an area which as well as slowing down the rate of runoff provides a number of environmental, ecological and social benefits.

These include:

- Protection and enhancement of water quality. As well as providing on-site attenuation, SuDS treat the water, resulting in an improved quality of water leaving the site. This is achieved when the water passes through fine soils and the roots of specially selected plants. Pollutants washed off the hard landscaping by rainfall will be safely removed before the water reaches the natural receiving water course.
- A sympathetic approach to the environmental setting by providing opportunities to create habitats for flora and fauna in urban watercourses and open spaces.
- Meeting the amenity and social needs of the local community and residents in the creation of attractive green spaces.

The various types of SuDS include:

Permeable paving	
Soakaways;	
Swales and basins;	
Bioretention/ rain gardens;	
Green roofs and rainwater re-use;	

Preferably a combination of these techniques should be used as part of the surface water management train, and it is important for all stakeholders, such as developers, architects, landscape architects and engineers to work in order to determine a feasible solution.

The SuDS management train is shown below, this has been followed when proposing the proposed Sustainable Urban Drainage Systems for this site.

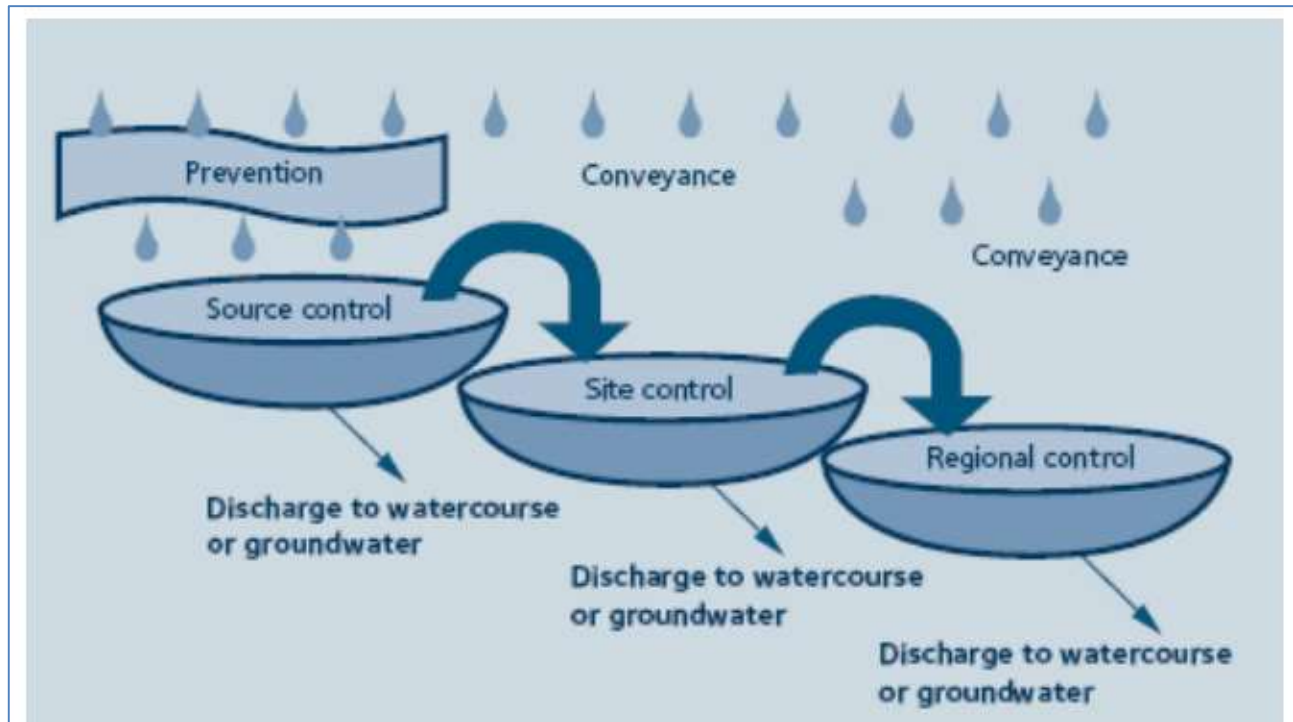


Figure 3 – SuDS Management Train

4. SuDS PROPOSALS FOR DEVELOPMENT

In accordance with the CIRIA SuDS Manual C753, the SuDS hierarchy has been considered in relation to the site-specific constraints and its surroundings. Table 1 below outlines the hierarchical approach considered for the development at Knowles Quarry, Barnsley Road, Cudworth, S27 8UU.

Sustainable Drainage Proposal	Description	Constraints/Comments	Appropriate
Rainwater Use as a Resource	Use of rainwater runoff for reuse, e.g. Rainwater harvesting tanks, Blue Roofs for irrigation	Wall mounted rainwater harvesting tanks have been proposed where feasible, for rainwater reuse.	Yes
Rainwater Full Infiltration to Ground (Source Control)	Infiltration devices and/or soakaways. Surface water runoff stored on site and gradually percolating into receiving ground	Due to the underlying geology consisting of mudstone, full infiltration is not feasible at this site	Yes
Rainwater Partial Infiltration to Ground (Source Control)	Installation of permeable/porous surfacing	Permeable paving proposed on all hardstanding areas to allow for partial infiltration in low intensity storm events	Yes
Rainwater attenuation in green infrastructure features for gradual release	The onsite storage of all surface water runoff which can then be gradually conveyed to a nearby watercourse, sewer or infiltration into the ground. Forms of green infrastructure features: Green Roofs, Raingardens, Ponds, Swales, Detention basins, Infiltration Trenches and Raingarden Planters	Due to the roofs being pitched, sedum or green roofs can not be provided. There is no available space for any above ground attenuation.	No

Rainwater discharge direct to a watercourse	All surface water runoff on site discharged at a restricted rate to a nearby watercourse	N/A due to there being no watercourses nearby	No
Controlled rainwater discharge to a surface water sewer or drain	All surface water runoff on site is discharged at a restricted rate to a nearby surface water sewer or drain, all rainwater runoff stored in below ground attenuation features. E.g. oversized pipes or geo-cellular tanks	N/A due to the system in the arear being a combined system	No
Controlled rainwater discharge to a combined sewer	All surface water runoff on site discharged at a restricted rate to a nearby surface water sewer all rainwater runoff stored in below ground attenuation features. E.g. oversized pipes or geo-cellular tanks	The surface water run off resulting from this proposed development will be attenuated at the site then discharged to the nearby combined sewer at a rate of 1 l/s in order to avoid blockages	No

Table 1: SuDS hierarchy

5. PROPOSED SUDS SOLUTION

The total site area is 1534m², with the impermeable areas at the existing site being 0m². Following the development at this site, the impermeable areas will have increased to 1094m². Pre and post development surface water run off calculations have been provided in Appendix A.

Due to the underlying geology consisting of mudstone, infiltration was deemed unfeasible for the site. However in order to ensure that the SuDS management train has been followed, we have proposed wall mounted rainwater harvesting tanks, where feasible.

All proposed hardstanding areas will be formed of porous surfacing, underlain by a hydrocarbon removing geotextile membrane at the entrance road and parking areas. The surface water run off from the sloped areas will be caught by slot drains.

The remaining surface water run off will be attenuated in a below ground crate system attenuation tank, with surface water run off leaving the site restricted to 1 l/s, in order to avoid blockages as the greenfield run off rate was too low.

Hydrograph storage calculation were carried out for the total contributing area for a 1 in 100 year storm event, with a 40% allowance for climate change. All surface water run off calculations can be found in Appendix A. The total storage required at the site has been calculated as 76m³, the restricted surface water runoff will be conveyed by either gravity or pumping into the combined sewer, as shown on drawing C2957-01 in Appendix B. No level information was provided by the water authority for this sewer, therefore we have shown a pumping station on this drawing, to show the worst case scenario.

6. FOUL DRAINAGE DESIGN

All new foul drains shall be constructed using 150mm nominal diameter pipework, which will discharge via gravity into the combined sewer as shown on the asset plans in Appendix C, and the proposed foul drainage layout plan can be seen on drawing C2957-01 in Appendix B.

7. TIMESCALE AND MAINTENANCE OF WORKS

All drainage works will be completed prior to first occupation and there will be no adoption of any of the drainage works within the site, the managers of the site will be responsible to oversee the short and long term maintenance of the guttering's, pipes and manholes, as well as the short and long term maintenance of the attenuation tanks, catchpit chambers, as well as the flow controls.

The following outline maintenance strategy sets out recommended timescales for maintenance of the proposed drainage works, in line with CIRIA SuDS Design Guide.

- Regular inspection will comprise the inspection and cleaning of catchment, gutters, filters and tanks to reduce the likelihood of contamination, this is recommended to be carried out every 3 to 6 months.
- Regular jet-washing of permeable block paving can be used to keep joints and voids clear, this should be carried out every 6 months
- The catch pit chamber to and from the attenuation tank should be emptied every 3 months, and after every large storm event to ensure that there are no blockages.

- Periodic inspections & removal of debris of rainwater harvesting tanks that represent blockage risks
- The attenuation tank access chamber is to be checked every 3 to 6 months to ensure that there are no blockages, however, if the catchpit chamber is cleaned and emptied every 3 months, and after every large storm event, there should be no issues with any debris blocking up the attenuation tank.

The following table outlines the maintenance requirements for the porous surfacing:

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations or clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this is the most likely to collect the most sediment
Occasional maintenance	Stabilise and mow contributing and adjacent areas	As required
	Removal of weeds or management using glyphosate applied directly into the weeds by an applicator rather than spraying	As required
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50 mm of the level of the paving.	As required
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing material.	As required
	Rehabilitation of surface and upper substructure by remedial sweeping	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
Monitoring	Initial inspection	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action	Three-monthly, 48hr after large storms in six months
	Inspect slit accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

Table 2: Operation and maintenance requirements for permeable paving.

The following table outlines the maintenance requirements for the attenuation storage tanks:

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action.	Monthly for 3 months, then annually
	Remove debris from the catchment surface (where it may cause risks to performance).	Monthly
	For systems where rainfall infiltrates into the tank from above, check surface of filter for blockage by sediment, algae or other matter; remove and replace surface infiltration medium as necessary.	Annually
	Remove sediment pre-treatment structures and/or internal forebays.	Annually, or as required
Remedial actions	Repair/rehabilitate inlets, outlet, overflows and vents.	As required
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed	Annually
	Survey inside of tank for sediment build-up and remove if necessary	Every 5 years or as required
	Inspect slit accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

Table 3: Operation and maintenance requirements for attenuation storage tanks

The following table outlines the maintenance requirements for rainwater harvesting tank:

Maintenance schedule	Required action	Typical Frequency
Regular maintenance	Inspection of the tank for debris and sediment build-up, inlets/outlets/withdraw devices, overflow areas, pumps, filters	Annually (and following poor performance)
	Cleaning of tank, inlets, outlets, gutters. Withdrawal devices and roof drain filters of silts and other debris	Annually (and following poor performance)
Occasional maintenance	Cleaning and/ or replacement of any filters	Three monthly (or as required)
Remedial actions	Repair of overflow erosion damage or damage to tank	As required
	Pump repairs	As required

Table 4: Operation and maintenance requirement for rainwater harvesting systems

The following table outlines the maintenance requirements for rainwater harvesting tank:

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Inspect from surface and identify any areas that are not operating correctly. If required, take remedial action	Monthly for 3 months, then 6 monthly intervals
	Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
	Orifice plates within plastic chambers or vortex controls to be jetted from the surface after heavy rainfall events to remove any debris or silt	As required
	Empty catchpits upstream of SuDS features to ensure no debris is passed downstream	3 months or as required
Remedial actions*	In the event of a blockage, a vortex flow control can be removed from the chamber via the lifting cabled located at the access, this will be cleaned at surface level and reinstalled into its original location	As required
	In the event of a blockage, the orifice plate should be jetted from surface, and if blockage is not cleared the orifice plate can be removed by removing fixing bolts. These fixing bolts should be checked and replaced if needed.	As required
Monitoring	Following installation it is important that any extraneous materials i.e. building materials: granular backfill, in-situ pour concrete etc are removed from the unit and the new flow control chamber is fully jetted down	Upon installation
	Inspect/check chamber channel for any debris or silt build-up. Upstream chambers should be checked at the same time as these monitoring works to ensure network is operating at full capacity.	Annually

Table 5: Operation and maintenance requirements for flow control chambers

*All Remedial Works should be carried out by a competent and certified contractor, with no access to chambers or removal of parts to be undertaken by homeowners

If upstream network of flow control chamber is regularly maintained, little maintenance is required within the chamber as there are no moving parts

8. CONCLUSIONS

The purpose of this report and associated drawings, is to provide the local planning authority with a drainage strategy.

As requested, SuDS have been incorporated into this design, in the form of the following:

1. All new hardstanding surfaces being formed of permeable paving, underlain by a hydrocarbon removing geotextile membrane at the entrance road and parking areas.
2. The installation of wall mounted rainwater harvesting tanks for rainwater reuse, where feasible.
3. All surface water runoff being conveyed via an attenuation tank, with restricted discharge into the existing combined sewer adjacent to the site.
4. Foul flows to be conveyed via gravity to the combine sewer at the front of the site.

APPENDIX A – SURFACE WATER RUN OFF CALCULATIONS



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Sheet no. 1		
Date 23/04/23		
By S.L	Checked	Reviewed

MasterDrain
HY 10.01

Project Knowles Quarry
Title Pre & post SW Calcs prior to SuDS mitigation

Data:-

Hydrology (FSR):-

Location = BARNSELEY (W.YORKS)

Long reference = 434406

M5-60 (mm) = 18.8

r = 0.36

Hyd. area = 3

Hydrograph = Winter

WRAP = 2

Grid reference = SE3406

SAAR (mm/yr) = 675

Soil = 0.30

Hyd. zone = 8

Area = England & Wales

Site values used in design:-

Total site area = 0.1534 ha

Pre-dev area drained = 0.0000 ha

Imperm runoff factor = 100%

Climate change factor = 40%

Post-dev area drained = 0.1094 ha

Perm runoff factor = 20%

Pre-development

Area to soakaways = 0.0000 ha

Perv. area to SU DS = 0.0000 ha

Area to other SU DS = 0.0000 ha

Pre-dev flow to drain = 0.00 l/s

Post-development

Area to soakaways = 0.0000 ha

Perv. area to SU DS = 0.0000 ha

Area to other SU DS = 0.0000 ha

Post-dev flow to drain = 0.00 l/s

Calculations:-

Revised Post-dev Imperm. area = 0.109 ha

Equiv. Post-dev Imperm. area = 0.109 ha

Equiv. Post-dev Perm. area = 0.009 ha

Total Pre-dev equiv. area ha = 0.031 ha

Total Post-dev equiv. area ha = 0.118 ha

100 yr 6 hour mean intensity = 10.30mm/hr

Results:-

Pre-dev peakflow runoff (l/s) (m^3/s)

R.P.	15	30	60	120	240	360	480	600	Max	CCF	Final	R.P.
1	6.0	3.9	2.6	1.6	1.0	0.8	0.6	0.5	6.0	N/A	6.0	1
30	14.6	9.7	6.2	3.8	2.3	1.7	1.4	1.2	14.6	N/A	14.6	30
100	18.9	12.7	8.1	5.0	3.0	2.2	1.8	1.5	18.9	N/A	18.9	100

Post-dev peakflow runoff (l/s)

R.P.	15	30	60	120	240	360	480	600	Max	CCF	Final	R.P.
1	23.3	15.2	9.9	6.3	3.9	3.0	2.5	2.1	23.3	40	32.6	1
30	56.4	37.4	23.7	14.6	8.8	6.5	5.2	4.4	56.4	40	79.0	30
100	72.9	48.8	31.2	19.3	11.5	8.5	6.8	5.7	72.9	40	102.1	100

100 year 6 hour (x Climate Change Factor) storm gives:-

Pre-dev runoff volume m^3 = 19.0 m^3

Post-dev rainfall volume = 102.2 m^3

Post-dev volume m^3 (excess above SU DS) = 102.2 m^3

100 yr 6 hour mean intensity = 10.30mm/hr

Pre-dev volume to drain at 0 l/s = 0.0 m^3

Post-dev volume to drain at 0 l/s = 0.0 m^3

Post-dev storage volume = 102.2 m^3

Post-dev 5mm imperm volume = 5.5 m^3

Post-dev 5mm perm volume = 2.2 m^3

$Q_{BAR(rural)}$ = 0.268 l/s or 1.747 l/s/ha or 0.000 cumecs - from IoH 124.

The rainfall rates are calculated using the location specific values above in accordance with the Wallingford procedure.



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Title Pre & post SW Calcs prior to SuDS mitigation			

Data summary.

Use the data below for the SUR1 form

Site areas:-

Total site area	=	0.1534 ha ;1534.0 m ² [3A]
Pre-development impermeable area	=	0.0000 ha [3B]
Pre-development permeable area	=	0.1534 ha
Post-development impermeable area	=	0.1094 ha [3C]
Post-development permeable area	=	0.0440 ha

Peak runoff:-

Pre-development 1 year storm (15min)	=	6.0 l/s [6A]
Pre-development 100 year storm (15min)	=	18.9 l/s [6C]
Post-development 1 year storm (15min)	=	23.3 l/s [6B]
Post-development 100 year storm (15min)=		72.95 l/s [6D]

Greenfield runoff:-

$$Q_{\text{BAR(rural)}} = 0.268 \text{ l/s or } 1.747 \text{ l/s/ha or } 0.000 \text{ cumecs - from IoH 124.}$$

Climate change factor:-

$$\text{CCF} = 40\%$$

Volumes:-

Pre-development 100 yr/6hr storm [12A]	=	26.5m ³
Post-development 100 yr/6hr storm (add. volume with no SUDS) [12B]	=	102.2m ³
Post-development 100 yr/6hr storm (add. volume with SUDS)	=	102.2m ³
Post-development add. predicted volume (No SUDS) [12C]	=	75.7m ³

You may also require

Data relating to the infiltration test calculations (if applicable)
Evidence to show runoff reduction (if applicable)
Information on calculation methods (if applicable see next sheet)

Note

Numbers in square brackets relate to the
Nov. 2010 v1.1 / issued 11/02/10 copy of SUR1



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Title Pre & post SW Calcs prior to SuDS mitigation			

Definitions and methods

Hydrology

The hydrological constants are derived from the Wallingford maps. They are used to calculate location specific rainfall figures.

Site values and factors

Areas of the site should be entered in hectares (10000 m²). If the Pre-development site is a green field, this box is blank.

Climate Change Factor is initially set at 20% - this may be changed as required.

Greenfield runoff is calculated using the method described in loH 124.

Runoff factors

The impermeable runoff factor is initially set at 98%

The permeable runoff factor is initially set at 20%

Note: the CCF and the runoff factors may be changed by the user to suit the development

The areas draining to soakaways and other SUDS are entered in the appropriate box (in hectares)

Calculations

The post-development area is reduced by subtracting the areas that drain to soakaways or other SUDS, to give a revised figure.

All areas are then multiplied by the appropriate runoff factor to give an equivalent area with 100% runoff.

These are then summated.

This gives a total pre-development equivalent area, and a similar figure for the post-development area.

The 'Post-dev volume to drain (no SUDS)' gives the total runoff to drain if no SUDS were used.

Results

The pre- and post-development areas are subjected to 1,30 and 100 year return period storms with a duration of 15 to 600 minutes.

The Revised Post-dev Imperm. area is the area (in ha) that is not going to SUDS x impervious runoff factor.

The runoff rates are calculated for the chosen hydrograph (Summer or Winter) as l/s. Figures in red indicate m³/s

The peak value is measured, multiplied by the CCF and the total maximum rate is shown.

The pre- and post-development volumes for a 100 year / 6 hour storm are calculated from the area under the hydrograph curve.

Post-dev volume (i.e. excess above SUDS) is that volume produced by the drained area that does not go to SUDS.

Qbar(rural) is calculated in accordance with the procedure laid down in loH 124



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Project **Knowles Quarry**
Title **IoH 124 (Qbar(urban))Runoff calcs**

Hydrological Data:-

FSR Hydrology:-

Location = BARNSELEY (W.YORKS)	Grid reference = SE3406
M5-60 (mm) = 18.8	r = 0.36
Soil runoff = 0.30	SAAR (mm/yr) = 675
WRAP = 2	Area = England & Wales
Hydrological area = 3	Hydrological zone = 8

Soil classification for WRAP type 2

- i) Very permeable soils with shallow ground water;
- ii) Permeable soils over rock or fragipan, commonly on slopes in western Britain associated with smaller areas of less permeable wet soils; (fragipan - a natural subsurface horizon having a higher bulk density than the solum above. Seemingly cemented when dry but showing moderate to weak brittleness when moist. The layer is low in organic matter, mottled and slowly or very slowly permeable to water. It is found in profiles of either cultivated or virgin soils but not in calcareous material).
- iii) Moderately permeable soils, some with slowly permeable subsoils.

Design data:-

Area = 0.001534 Km² - 0.153 Ha - 1534 m² % Urbanisation = 0.00%

Calculation method:-

Runoff is calculated from:-

$$Q_{BAR(urban)} = Q_{BAR(rural)} (1 + URBAN)^{2NC} [1 + URBAN \{ (21/CIND) - 0.3 \}]$$

where:-

NC varies with the value of SAAR:-

for 500<SAAR<1100 mm then NC = 0.92 - 0.00024SAAR

for 1100<SAAR<3000 mm then NC = 0.74 - 0.000082SAAR

CIND = 102.4SOIL + 0.28(CWI - 125) CWI = Catchment Wetness Index

so

CIND =15.686

CWI =71.307

NC =0.758

For areas less than 50Ha, a modified calculation which multiplies the 50Ha runoff value by the ratio of the site area to 50Ha is used
Reducing factor used for these calculations is 0.003

$$Q_{BAR(rural)} = 0.268 \text{ (l/s)}$$

$$Q_{BAR(urban)} = 0.268 \text{ (l/s)}$$

$Q_{BAR(urban)}$ is then multiplied by a growth factor - GC(T) - for different storm return periods derived from EA publication W5-074/A.



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Calculated data:-

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Title IoH 124 (Qbar(urban))Runoff calcs						

Mean Annual Peak Flow $Q_{BAR(urban)} = 0.27 \text{ l/s}$

Values for $Q_{BAR(urban)}$

Ret. per.	m ³ /hr	l/s	l/s/ha	Ret. per.	m ³ /hr	l/s	l/s/ha
1yr	0.000	0.228	1.485	100yr	0.001	0.563	3.668
2yr	0.000	0.252	1.642	100yr+20%	0.001	0.675	4.401
5yr	0.000	0.324	2.113	100yr+30%	0.001	0.731	4.768
10yr	0.000	0.388	2.532	200yr	0.001	0.643	4.192
30yr	0.000	0.450	2.934	200yr + 30%	0.001	0.836	5.449
50yr	0.001	0.509	3.318	500yr	0.001	0.731	4.768
				1000yr	0.001	0.814	5.309

Growth factors -

1yr	2yr	5yr	10yr	30yr	50yr	100yr	200yr	500yr	1000yr
0.85	0.94	1.21	1.45	1.68	1.90	2.10	2.40	2.73	3.04

The above is based on the Institute of Hydrology Report 124 to which you are referred for further details (see Sect 7). Note that the 200 year growth curve was taken from W5-074/A.

For WRAP type 1 soils, CIND can become negative for lower values of SAAR. In this case the CIND value is multiplied by -1 to return a positive value (CIND is very small at this point).



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Date	23/04/23		
By	SL	Checked	Reviewed

Project **Knowles Quarry**

Title **Hydrograph storage calcs with 1 l/s discharge**

Data:-

Location = BARNSELY (W.YORKS) Grid reference = SE3406
M5-60 (mm) = 18.8 r = 0.36
Soil index = 0.30 SAAR (mm/yr) = 675
Return period = 100 WRAP = 2
UCWI = 0.0 Climate change = 40%

- i) Very permeable soils with shallow ground water;
- ii) Permeable soils over rock or fragipan, commonly on slopes in western Britain associated with smaller areas of less permeable wet soils; The layer is low in organic matter, mottled and (fragipan - a natural subsurface horizon having a higher bulk density than the solum above. Seemingly cemented when dry but showing moderate to weak brittleness when moist. Slowly or very slowly permeable to water. It is found in profiles of either cultivated or virgin soils but not in calcareous material).
- iii) Moderately permeable soils, some with slowly permeable subsoils.

Pipeline storage = 0.0 m³ Available MH storage = 0.0 m³
Offline storage = 0.0 m³

Percentage runoff = 100.0% (manual setting)

Imperv. area = 1094 m² Pervious area = 0 m²
Total area = 1094 m² Equiv area = 1094 m² (Tot. area x % runoff).
Total runoff = 101.2 m³ Discharge rate = 1.000 l/s
Storage (m³) = 76.0 m³ (Sum of all balance quantities)
Total rainfall depth = 92.5 mm

Calculations :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
0.080	20.0	2.3	0.202	0.288	0.000	0.000
0.160	20.0	2.3	0.202	0.288	0.000	0.000
0.240	21.0	2.4	0.213	0.288	0.000	0.000
0.320	21.0	2.4	0.213	0.288	0.000	0.000
0.400	22.0	2.5	0.223	0.288	0.000	0.000
0.480	23.0	2.7	0.233	0.288	0.000	0.000
0.560	24.0	2.8	0.243	0.288	0.000	0.000
0.640	26.0	3.0	0.263	0.288	0.000	0.000
0.720	27.0	3.1	0.273	0.288	0.000	0.000
0.800	29.0	3.4	0.294	0.288	0.006	0.006
0.880	31.0	3.6	0.314	0.288	0.026	0.031
0.960	32.0	3.7	0.324	0.288	0.036	0.067
1.040	33.0	3.8	0.334	0.288	0.046	0.113
1.120	34.0	3.9	0.344	0.288	0.056	0.169
1.200	36.0	4.2	0.364	0.288	0.076	0.246
1.280	38.0	4.4	0.385	0.288	0.097	0.342
1.360	39.0	4.5	0.395	0.288	0.107	0.449
1.440	40.0	4.6	0.405	0.288	0.117	0.566
1.520	42.0	4.9	0.425	0.288	0.137	0.703
1.600	45.0	5.2	0.455	0.288	0.167	0.870
1.680	49.0	5.7	0.496	0.288	0.208	1.078
1.760	53.0	6.1	0.536	0.288	0.248	1.327
1.840	57.0	6.6	0.577	0.288	0.289	1.616
1.920	62.0	7.2	0.628	0.288	0.340	1.955
2.000	66.0	7.6	0.668	0.288	0.380	2.335
2.080	71.0	8.2	0.719	0.288	0.431	2.766
2.160	77.0	8.9	0.779	0.288	0.491	3.257
2.240	84.0	9.7	0.850	0.288	0.562	3.819
2.320	91.0	10.5	0.921	0.288	0.633	4.452
2.400	98.0	11.3	0.992	0.288	0.704	5.156
2.480	105.0	12.1	1.063	0.288	0.775	5.931
2.560	114.0	13.2	1.154	0.288	0.866	6.797
2.640	125.0	14.5	1.265	0.288	0.977	7.774



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Sheet no. 2		
Date 23/04/23		
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Project Knowles Quarry	
Title Hydrograph storage calcs with 1 l/s discharge	

Calculations (cont.) :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
3.280	204.0	23.6	2.065	0.288	1.777	19.133
3.360	212.0	24.5	2.146	0.288	1.858	20.991
3.440	219.0	25.3	2.217	0.288	1.929	22.919
3.520	226.0	26.1	2.287	0.288	1.999	24.919
3.600	233.0	26.9	2.358	0.288	2.070	26.989
3.680	239.0	27.6	2.419	0.288	2.131	29.120
3.760	244.0	28.2	2.470	0.288	2.182	31.301
3.840	248.0	28.7	2.510	0.288	2.222	33.523
3.920	249.0	28.8	2.520	0.288	2.232	35.756
4.000	250.0	28.9	2.530	0.288	2.242	37.998
4.080	250.0	28.9	2.530	0.288	2.242	40.240
4.160	249.0	28.8	2.520	0.288	2.232	42.472
4.240	248.0	28.7	2.510	0.288	2.222	44.694
4.320	244.0	28.2	2.470	0.288	2.182	46.876
4.400	239.0	27.6	2.419	0.288	2.131	49.007
4.480	233.0	26.9	2.358	0.288	2.070	51.077
4.560	226.0	26.1	2.287	0.288	1.999	53.076
4.640	219.0	25.3	2.217	0.288	1.929	55.005
4.720	212.0	24.5	2.146	0.288	1.858	56.862
4.800	204.0	23.6	2.065	0.288	1.777	58.639
4.880	194.0	22.4	1.963	0.288	1.675	60.315
4.960	183.0	21.2	1.852	0.288	1.564	61.879
5.040	173.0	20.0	1.751	0.288	1.463	63.342
5.120	164.0	19.0	1.660	0.288	1.372	64.714
5.200	154.0	17.8	1.559	0.288	1.271	65.984
5.280	143.0	16.5	1.447	0.288	1.159	67.144
5.360	135.0	15.6	1.366	0.288	1.078	68.222
5.440	125.0	14.5	1.265	0.288	0.977	69.199
5.520	114.0	13.2	1.154	0.288	0.866	70.065
5.600	105.0	12.1	1.063	0.288	0.775	70.840
5.680	98.0	11.3	0.992	0.288	0.704	71.543
5.760	91.0	10.5	0.921	0.288	0.633	72.176
5.840	84.0	9.7	0.850	0.288	0.562	72.739
5.920	77.0	8.9	0.779	0.288	0.491	73.230
6.000	71.0	8.2	0.719	0.288	0.431	73.661
6.080	66.0	7.6	0.668	0.288	0.380	74.041
6.160	62.0	7.2	0.628	0.288	0.340	74.380
6.240	57.0	6.6	0.577	0.288	0.289	74.669
6.320	53.0	6.1	0.536	0.288	0.248	74.917
6.400	49.0	5.7	0.496	0.288	0.208	75.125
6.480	45.0	5.2	0.455	0.288	0.167	75.293
6.560	42.0	4.9	0.425	0.288	0.137	75.430
6.640	40.0	4.6	0.405	0.288	0.117	75.547
6.720	39.0	4.5	0.395	0.288	0.107	75.653
6.800	38.0	4.4	0.385	0.288	0.097	75.750
6.880	36.0	4.2	0.364	0.288	0.076	75.826
6.960	34.0	3.9	0.344	0.288	0.056	75.882
7.040	33.0	3.8	0.334	0.288	0.046	75.928
7.120	32.0	3.7	0.324	0.288	0.036	75.964
7.200	31.0	3.6	0.314	0.288	0.026	75.990
7.280	29.0	3.4	0.294	0.288	0.006	75.996
7.360	27.0	3.1	0.273	0.288	0.000	75.981
7.440	26.0	3.0	0.263	0.288	0.000	75.956
7.520	24.0	2.8	0.243	0.288	0.000	75.911
7.600	23.0	2.7	0.233	0.288	0.000	75.856
7.680	22.0	2.5	0.223	0.288	0.000	75.790
7.760	21.0	2.4	0.213	0.288	0.000	75.715
7.840	21.0	2.4	0.213	0.288	0.000	75.639
7.920	20.0	2.3	0.202	0.288	0.000	75.554
8.000	20.0	2.3	0.202	0.288	0.000	75.468

Storage volume (m³) = 76.0 m³ (Sum of all balance quantities)



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Job No.
C2957

Sheet no. **3**

Date **23/04/23**

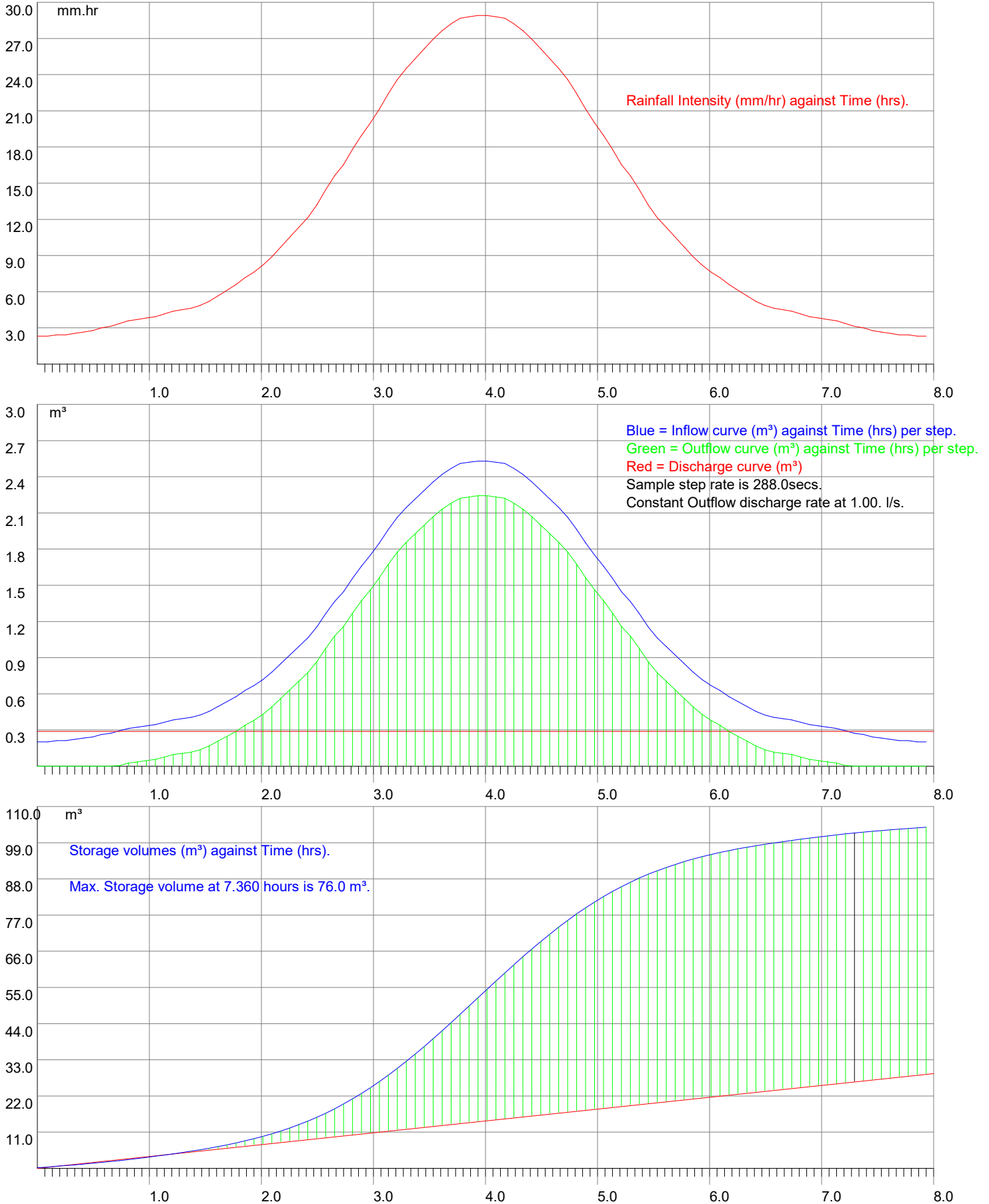
Project
Knowles Quarry

Title
Hydrograph storage calcs with 1 l/s discharge

By
SL

Checked

Reviewed





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Job No. C2957		
Sheet no. 4		
Date 23/04/23		
By SL	Checked	Reviewed

Project **Knowles Quarry**
Title **Hydrograph storage calcs with 1 l/s discharge**

Maximum storage volumes for varying duration storms.

Storm length (hrs)	Max. Vol (m ³)	Max. Vol time	Mean intens (mm/hr)	Step time. (mins)	Peak found
0.25	33.98	0.25	124.41	0.2	
0.5	44.88	0.50	83.25	0.3	
1	56.04	1.00	53.19	0.6	
2	66.45	2.00	32.84	1.2	
3	71.36	3.00	24.42	1.8	
4	73.81	4.00	19.67	2.4	
5	74.81	5.00	16.55	3.0	
6	75.56	6.00	14.41	3.6	
7	75.92	7.00	12.81	4.2	
8	76.00	8.00	11.56	4.8	Peak found
9	75.85	---	10.56	5.4	
10	75.57	---	9.74	6.0	
12	74.77	---	8.46	7.2	
15	73.24	---	7.12	9.0	
18	71.25	---	6.18	10.8	
20	69.77	---	5.69	12.0	
24	66.56	---	4.94	14.4	
30	61.49	---	4.14	18.0	
36	56.21	---	3.59	21.6	
42	50.97	---	3.18	25.2	
48	45.84	---	2.86	28.8	
54	40.79	---	2.61	32.4	
60	35.87	---	2.40	36.0	
66	31.21	---	2.22	39.6	
72	26.72	---	2.07	43.2	
84	18.52	---	1.84	50.4	
96	11.40	---	1.65	57.6	
120	1.36	---	1.38	72.0	
150	0.00	---	1.15	90.0	
175	0.00	---	1.02	105.0	
200	0.00	---	0.92	120.0	
250	0.00	---	0.77	150.0	
300	0.00	---	0.66	180.0	
375	0.00	---	0.56	225.0	
500	0.00	---	0.44	300.0	
750	0.00	---	0.32	450.0	
1000	0.00	---	0.26	600.0	
1250	0.00	---	0.22	750.0	
1500	0.00	---	0.19	900.0	
1570	0.00	---	0.18	942.0	
2000	0.00	---	0.15	1200.0	
2500	0.00	---	0.13	1500.0	
3000	0.00	---	0.11	1800.0	
3500	0.00	---	0.10	2100.0	
4000	0.00	---	0.09	2400.0	



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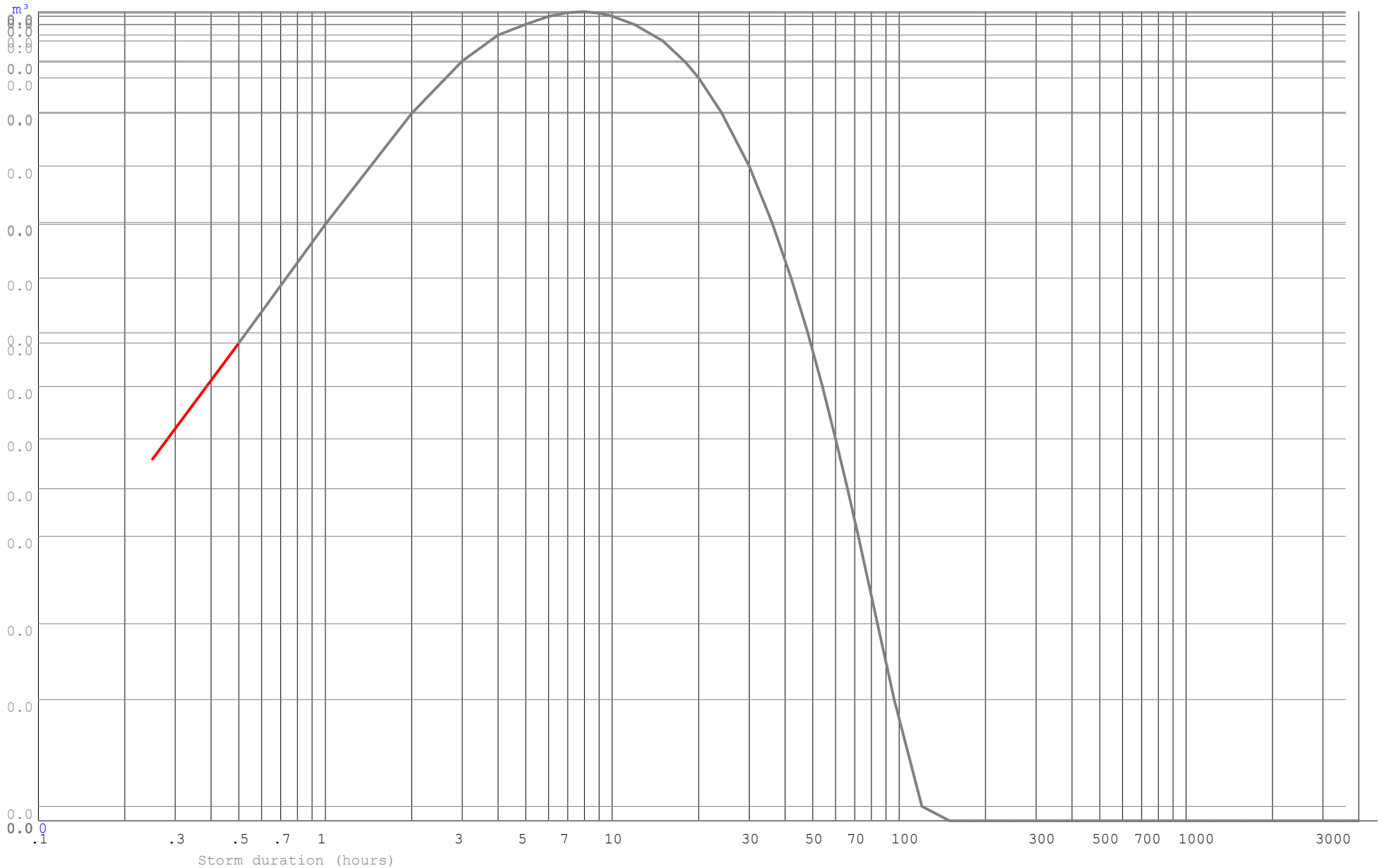
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Job No. C2957		
Sheet no. 5		
Date 23/04/23		
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Project
Knowles Quarry

Title
Hydrograph storage calcs with 1 l/s discharge

Sequential storage volume at specific storm durations.





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Date 23/04/23		
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Project
Knowles Quarry

Title
Hydrograph storage calcs with 1 l/s discharge

Explanatory notes for Peak Flow Storage

- 1) This system uses the rainfall intensity/ duration curve calculated using either the Wallingford or FEH method as selected.
- 2) The balance is calculated from the inflow minus the outflow.
- 3) The storage volume is the maximum value of the balance curve.
- 4) This method was described by Davis (1963) - see Butler & Davies, 2nd edition, p294
- 5) References to 'storm duration' relate only to the hydrograph method (qv).
- 6) There are always 600 steps in the calculation process, thus a 'run' time of 10 hours will be sampled every minute,

Explanatory notes for Hydrograph Storage

- 1) The user has the choice of Summer or Winter curves
- 2) The mean intensity varies with the duration of the storm curve
- 3) There are always 120 steps in the calculation process, irrespective of storm duration.
- 4) The balance is calculated from the inflow minus the outflow.
- 5) The storage volume is the sum of the balance values for each step.
- 6) Varying durations should be tried to find the maximum storage value - this can be narrowed down very closely.

*Modelling using the flow characteristics of the restrictor is available using Vortex Control modelling function. Please be aware that this function needs the full design data file to function.

Why do the two methods give different results?

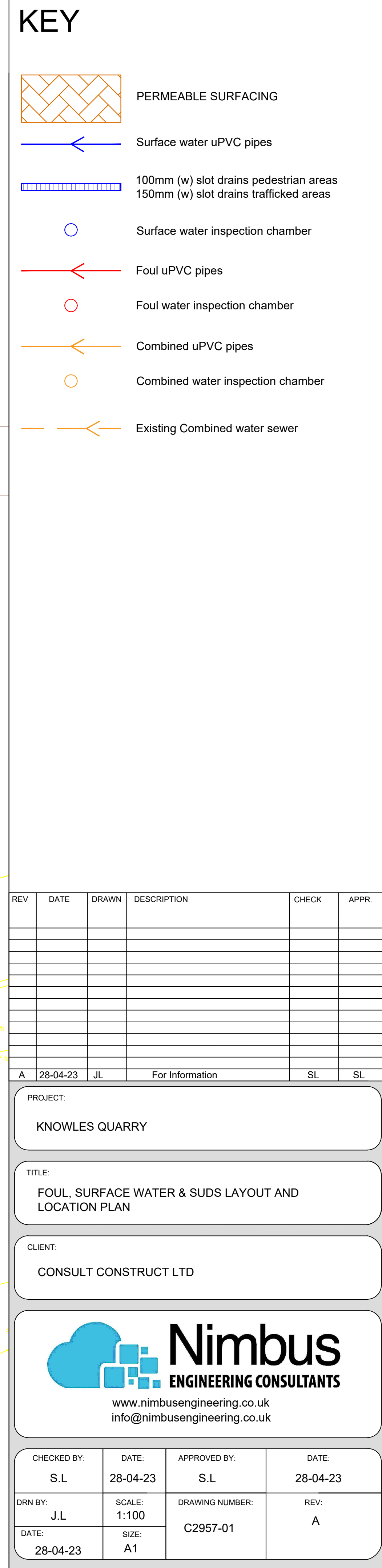
The rainfall characteristics for each method are very different.

The Peak flow (using the Intensity/Duration/Frequency curve) does not model the actual rainfall. This curve is joined points which represent the mean intensity of a storm at a given duration i.e. a value of 19.5 mm/hr for a 60 minute storm indicates that over the sixty minute period, the mean intensity was 19.5 mm/hr. The calculation method samples the IDF curve for a given location and frequency (Return Period) and calculates the storage for that rate and duration less the outflow volume. The maximum value is displayed as the 'worst case' storage.

The hydrograph method uses a standard curve for either Winter or Summer storms. Traditionally these are symmetrical about the central peak. UK rainfall does not fit into this convenient curve, so the calculations are dealing with a stylised set of data. The mean intensity for the storm is calculated from the IDF curve and applied to the curve data, calculating the storage for that step less the outflow volume. The final storage volume is the sum of the storage for all the steps.

It can be seen that these two methods are very different, and the user may have the choice of which result to use. This is not an exact science, though is often treated as such by those that do not understand the principles of the calculations.

APPENDIX B – DRAWINGS



REV	DATE	DRAWN	DESCRIPTION	CHECK	APPR.
A	28-04-23	JL	For Information	SL	SL

PROJECT:

KNOWLES QUARRY

TITLE:

FOUL, SURFACE WATER & SUDS LAYOUT AND LOCATION PLAN

CLIENT:
CONSULT CONSTRUCT LTD



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CHECKED BY: S.L	DATE: 28-04-23	APPROVED BY: S.L	DATE: 28-04-23
DRN BY: J.L	SCALE: 1:100	DRAWING NUMBER: C2957-01	REV: A
DATE: 28-04-23	SIZE: A1		

APPENDIX C – WATER AUTHORITY ASSET PLANS

Nimbus Engineering
Consultants
124-128 City Road
London
EC1V 2NX

Your Ref:

Our Ref: CAS-257008-F2H7G5

SafeMove
PO Box 99
Bradford
BD3 7YB
Tel 0333 220 6664

21 April 2023.

Dear Sirs,

Thank you for your request dated 21 April 2023.

Please find enclosed the results of your Asset Record Search.

If you need to discuss anything please do not hesitate to contact us.

SafeMove enquiry completed for

VAT Regn. No. 500 5557 80

Net Amount (VAT Chargeable)	£24.00
Net Amount (VAT Exempt)	£0.00
VAT 20% on £24.00	£4.80
Total Inc. VAT	£28.80

We thank you for your enquiry and hope we can be of assistance in the future.

Yours faithfully

SafeMove
Tel. 0333 220 6664

YORKSHIRE WATER PROTECTION OF MAINS AND SERVICES

1. The position of Yorkshire Water Services Ltd (YWS) apparatus shown on the existing mains record drawing(s) indicates the **general** position and nature of our apparatus and the accuracy of this information cannot be guaranteed. Any damage to YWS apparatus as a result of your works may have serious consequences and you will be held responsible for all costs incurred. Prior to commencing major works, the exact location of apparatus must be determined on site, if necessary by excavating trial holes. The actual position of such apparatus and that of service pipes which have not been indicated must be established on site by contacting the Customer Helpline on 0845 124 24 24 for both water and sewerage.
2. The public sewer and water network is lawfully retained in its existing position and the sewerage and water undertaker is entitled to have it remain so without any disturbance. The provisions of section 159 of the Water Industry Act 1991 provides that the undertaker may "inspect, maintain, adjust, repair or alter" the network. Those rights are given to enable the undertaker to perform its statutory duties. Any development of the land or any other action that unacceptably hindered the exercise of those rights would be unlawful. The provisions contained in Section 185 of the Water Industry Act 1991 state that where it is reasonable to do so, a person may require the water supply undertaker to alter or remove a pipe where it is necessary to enable that person to carry out a proposed change of use of the land. The provisions contained in Section 185 also require the person making the request to pay the full cost of carrying out the necessary works.
3. Ground levels over existing YWS apparatus are to be maintained. Sewers in highways will **generally** be laid to give 1200mm of cover from finished ground level working to kerb races, other permanent identification of the limits of the road or to an agreed line and level. Substantial increases or decreases to this 1200mm depth of cover will result in the sewer being re-laid at your expense. Water mains and services will **generally** be laid with a minimum of 750mm depth of cover however some mains and services usually those installed over 50 years ago may have less ground cover.
4. If surface levels are to be decreased / increased significantly the effects on existing water supply apparatus will be carefully considered and if any alterations are necessary, the costs of the alterations will be recharged to you in full. Outlets on fire hydrants must be no more than 300mm below the new levels and all surface boxes must be adjusted as part of the scheme.
5. To enable future repair works to be carried out without hindrance; any pipe, cable, duct, etc. installed parallel to a water main or service pipe should not be installed directly over or within 300mm of a water main or service pipe or 1000mm of a waste water asset. Where a pipe, cable, duct, etc. crosses a main or service it should preferably cross perpendicular or at an angle of no less than 45° and with a minimum clearance of 150mm. These requirements apply to activities within an existing highway and are relevant to the installation of pipes, cables, ducts, etc. up to and including 250mm in diameter (*see illustration below*). Necessary protection measures for installations greater than 250mm in diameter and/or in private land will need to be agreed on an individual basis. Installations within a new development site must comply with the National Joint Utilities Group publication Volume 2: NJUG Guidelines On The Positioning Of Underground Utilities Apparatus For New Development Sites.
6. All excavation works near to YW apparatus should be by hand digging only.
7. Backfilling with a suitable material to a minimum 300mm above YW apparatus is required.
8. Adequate support must be provided where any works pass under YW apparatus.
9. Jointing chambers, lighting columns and other structures must be installed in such a way that future repair or maintenance works to YW apparatus will not be hindered.
10. Apparatus such as; railings, sign posts, etc. must not be placed in such a way that they prevent access to or full operation of controlling valves, hydrants or similar apparatus. YWS surface boxes must not be covered or buried. Any adjustment, alteration or replacement of manhole covers must be agreed on site prior to the commencement of the works with a YWS Inspector who may be contacted via our Call Centre on 0845 124 24 24.
11. Explosives shall not be used within 100 metres of any Yorkshire Water Services apparatus or installations.
12. Vibrating plant should not be used directly over any apparatus. Movement or operation by vehicles or heavy plant is not to be permitted in the immediate vicinity of YWS plant or apparatus unless there has been prior consultation and, if necessary, adequate protection provided without cost to YWS.
13. **Under no circumstances** should thrust boring or similar trenchless techniques commence until the actual position of the Company's mains/services along the proposed route have been confirmed by trial holes.
14. Any alterations to the highway should be notified following the procedures outlined in the New Road and Street Works Act 1991 Code of Practice; Measures Necessary Where Apparatus Is Affected By Major Works (Diversionsary Works).
15. You will be held responsible for any damage or loss to YWS apparatus during and after completion of work, caused by yourselves, your servant or agent. Any damage caused or observed to YWS plant or apparatus should be immediately reported to YWS. Should YW incur any costs as a result of non-compliance with the above, all costs will be rechargeable in full.
16. You should ensure that nothing is done on the site to prejudice the safety or operation of YWS employees, plant or apparatus.
17. In accordance with the New Roads and Street Works Act 1991, Chapter 22, Part 3, Section 80. The location of any identified YW asset "which is not marked, or is wrongly marked, on the records made available" should be communicated back to Yorkshire Water. The location of the apparatus should be identified on copies of the supplied plans which should be returned to Yorkshire Water (Asset Records Team) with photographic supporting evidence where possible.
18. The Government has decided that responsibility for private sewers serving two or more properties and lateral drains (the section of pipe beyond the boundary of a single property, connecting it to the public sewer) will be transferred to the water companies on Oct 1 2011.

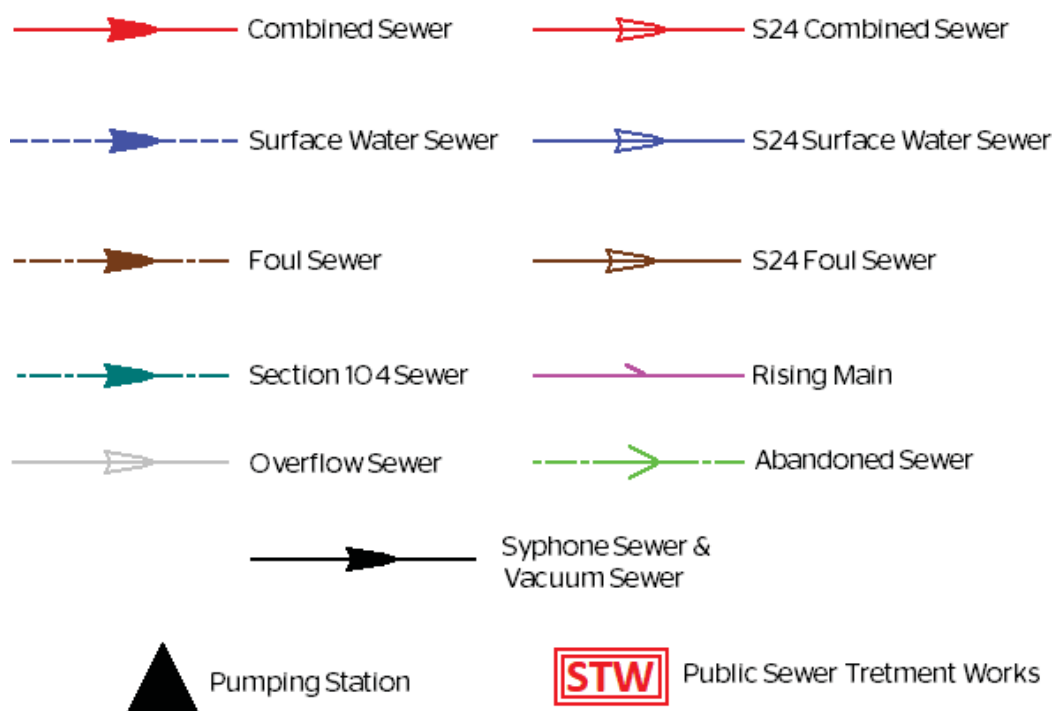
Private pumping stations will also transfer during the period 1 October 2011 – 1 Oct 2016. Records of these assets may not yet be shown on the existing mains record drawing(s). If you encounter any of these assets you must inform Yorkshire Water Services Ltd (YWS).

19. Please note that the information supplied on the enclosed plans is reproduced from Ordnance Survey material with the permission of the Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office, © Crown Copyright. Unauthorised reproduction infringes Crown Copyright and may lead to prosecution or civil proceedings. Licence Number 1000019559.
20. This information is for guidance only and the position and depth of any YW apparatus is approximate only. Likewise, the nature and condition of any YW apparatus cannot be guaranteed. YW has no responsibility for recording the locations of privately owned apparatus. As of 1 October 2011, there may be some lateral drains and/or public sewers which are not documented on YW records but may still be present. For the avoidance of doubt, this information is not a substitute for appropriate professional and/or legal advice. YW accepts no responsibility for any inaccuracy or omissions in this information. The actual position of YW apparatus must be determined on site by excavating trial holes by hand. YW requires a minimum of two working days' written notice of the intention to excavate any trial holes before any excavation can be undertaken. If there are any queries in this respect please contact Yorkshire Water on 0845 124 24 24.

Property Identifier

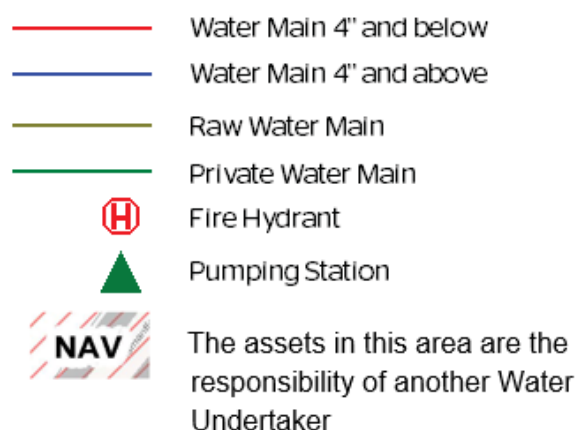


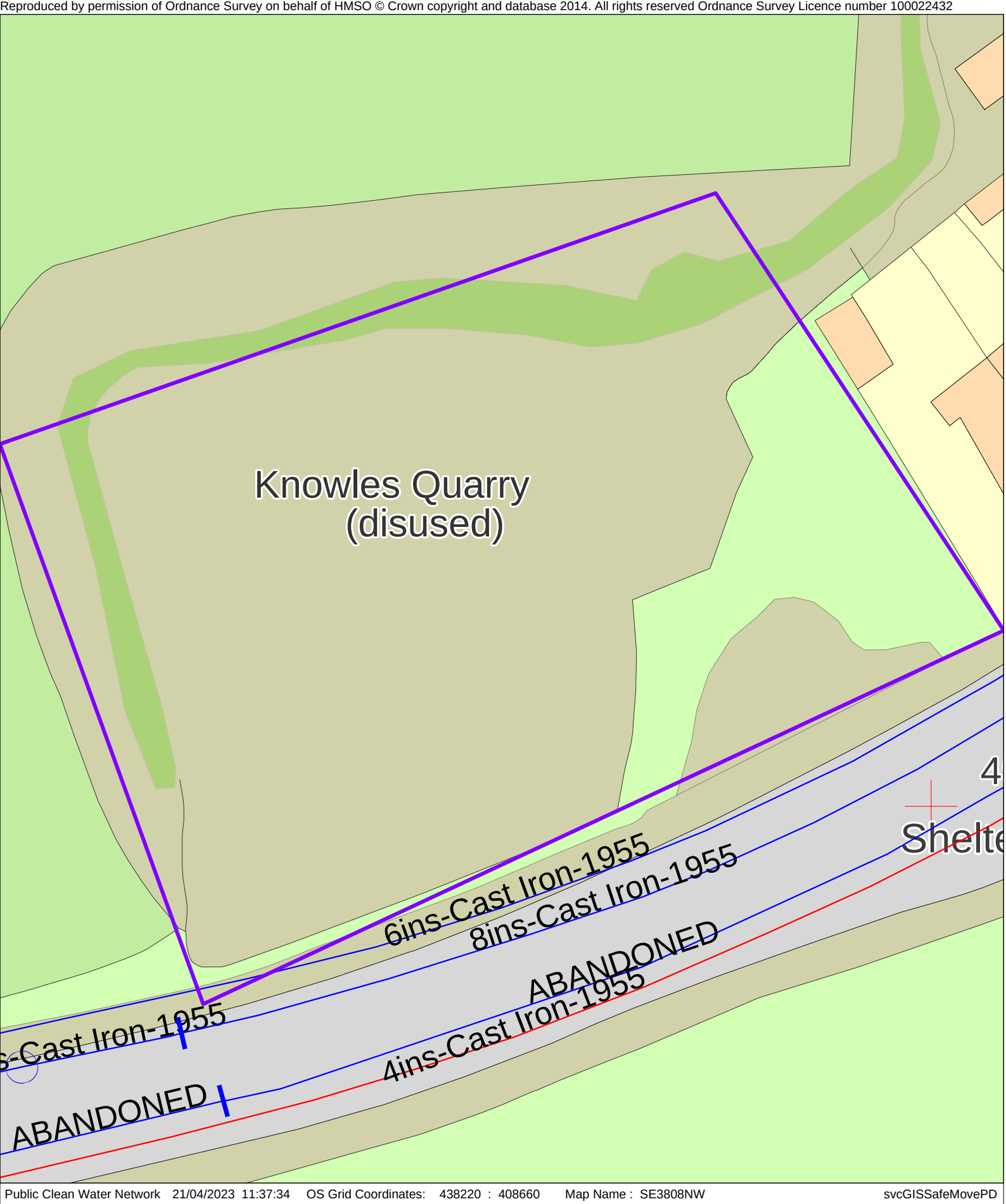
Sewer Legend



Please note that the direction of flow arrows may not always appear depending on the scale of the map.

Water Legend







Public Waste Water Network 21/04/2023 11:37:35 OS Grid Coordinates: 438220 : 408660 Map Name : SE3808NW svcGISSafeMovePD